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1 TECHNICAL FIELD

2 The present invention relates to cards, communication devices, and
3 methods of forming and encoding visibly perceptible information on the
4 same.

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6 BACKGROUND OF THE INVENTION

7 Cards such as credit cards, smart cards, badges, labels, stamps,
8 tags and electronic communication devices including radio frequency
9 identification device (RFID) cards typically include printed information
10 regarding the manufacture or issuance of the card on a face of the
11 card. The faces of such cards are normally used for advertising,
12 embossing, and providing signature panels, magnetic stripes, or end user
13 information. Alternatively, such information regarding the manufacture
14 or issuance of the card is not provided at all.

15 In many applications, providing of manufacturing or issuance
16 information upon one of the faces of the cards is not cosmetically
17 pleasing to the end user. However, this information is useful for
18 various reasons. For example, the printed information is valuable to
19 the end user for providing issuance information, security and/or tracking
20 of an associated product in many applications.

21 Therefore, there is a need to provide alphanumeric and other
22 information upon a card without impacting the cosmetic properties of
23 the card, or utilizing space which may be necessary for magnetic stripes,
24 signature lines, or other information.

1 SUMMARY OF THE INVENTION

2 One embodiment of the present invention provides a remote
3 intelligent communication device (RIC). The embodiment includes a
4 card-thin housing including at least one side having visibly perceptible
5 information thereon and communication circuitry within the housing and
6 configured to at least one of communicate (i.e., output) and receive
7 electronic signals. Other embodiments of the present invention provide
8 additional electronic communication devices including a radio frequency
9 identification device. The remote intelligent communication device and
10 radio frequency identification devices are wireless communication devices
11 according to preferred embodiments of the present invention.

12 A second aspect of the present invention provides a card having
13 plural surfaces, and a side intermediate the surfaces. The side has a
14 thickness less than about 100 mils. Indicia is provided on the side.

15 According to another aspect of the present invention, a
16 communication device is disclosed. The communication device includes
17 a substrate having a support surface, an antenna, transponder circuitry,
18 and a battery. A cured resin is provided upon the support surface, the
19 antenna, the transponder circuitry and the battery. The cured resin and
20 substrate form a housing. Identification indicia is encoded on at least
21 one of the side surfaces of the housing.

22 Another aspect of the present invention provides a method of
23 forming a card including moving at least one of a card and a print
24 head relative to the other of the card and print head. The method

1 additionally includes encoding visibly perceptible information on a side
2 of the card.

3 An additional aspect of the present invention provides a method
4 of forming a communication device. This method includes the steps of
5 providing a substrate, an antenna, and communication circuitry and
6 applying and curing an encapsulant to form a housing. The method
7 further includes encoding visibly perceptible information on a side
8 surface of the housing.

9 Another aspect provides a method of forming a remote intelligent
10 communication device. Additional methods according to the present
11 invention provide methods of encoding visibly perceptible information on
12 a communication device.

13 14 BRIEF DESCRIPTION OF THE DRAWINGS

15 Preferred embodiments of the invention are described below with
16 reference to the following accompanying drawings.

17 Fig. 1 is a block diagram of an electronic communication system
18 including an interrogator and an electronic communication device.

19 Fig. 2 is a front elevational view of the electronic communication
20 device.

21 Fig. 3 is a front elevational view of the electronic communication
22 device at an intermediate processing step.
23
24

1 Fig. 4 is an isometric view of the electronic communication device
2 of Fig. 2 having indicia on a side thereof in accordance with the
3 present invention.

4 Fig. 5 is an illustrative diagram of a first method and system for
5 providing indicia upon a side of the electronic communication device.

6 Fig. 6 is an illustrative diagram of another method and system for
7 providing indicia upon a side of the electronic communication device.
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9 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

10 This disclosure of the invention is submitted in furtherance of the
11 constitutional purposes of the U.S. Patent Laws "to promote the
12 progress of science and useful arts" (Article 1, Section 8).

13 The present invention provides indicia or other visibly perceptible
14 information upon a side or edge of a card. The present invention is
15 described with reference to the providing of indicia upon a side of an
16 electronic communication device provided in the form of a card. Such
17 indicia may be applied to other types of cards, including, for example,
18 credit cards, smart cards, badges, tags, stamps and labels. In addition,
19 such indicia may be applied to any device having a card-thin housing.
20 As used herein, "card-thin" refers to a housing or other supportive
21 substrate having a thickness less than 200 mils, and preferably less than
22 100 mils.

23 The electronic communication device is fabricated in a card
24 configuration in the described embodiment. The described embodiment

communications in the preferred embodiment of communication system 12. Communication system 12 further includes an antenna 16 coupled to the interrogator unit 14 to facilitate communications. Electronic communication arrangements other than wireless are possible within the present invention.

Referring to Fig. 2, the illustrated card 10 includes an insulative first substrate or layer of supportive material 18. Example materials for substrate 18 comprise polyester, polyethylene or polyimide film having a thickness of 4-6 mils (thousandths of an inch). A plurality of ink layers (not shown) are applied to substrate 18 in other embodiments of the invention. Substrate 18 includes an outer periphery 21. The substrate 18 defines a first portion of a housing for the electronic communication device or card 10. A ground plane can be provided over substrate 18 to improve the wireless communications of card 10. A dielectric layer is ideally provided over the ground plane in such embodiments.

An exemplary card 10 includes an upper surface 40, a lower surface 42 (not shown in Fig. 2) opposite surface 40, and a plurality of side surfaces 41 intermediate upper and lower surfaces 40, 42. Inks can be used to convey information such as logos and/or company names, such as those illustrated at 11. The inks may be viewed upon upper surface 40 of card 10.

Referring to Fig. 3, card 10 is shown at an intermediate processing step. A patterned conductive trace 30 is formed or applied

over a support surface 25 of substrate 18. A preferred conductive trace 30 comprises silver ink or printed thick film (PTF). One manner of forming or applying the conductive ink is to screen print the ink on the support surface 25 of substrate 18 through conventional screen printing techniques. The conductive ink forms desired electrical connections with and between electronic components which will be described below. In instances where substrate 18 forms a portion of a larger roll of polyester film material, the printing of the conductive trace 30 can take place simultaneously for a number of the to-be-formed electronic communication devices.

The illustrated conductive trace 30 provides antennas 32, 34 which are suitable for respectively receiving and transmitting electronic signals or RF energy. The illustrated antenna 32 constitutes a loop antenna. Other antenna constructions are possible. In other exemplary embodiments, antenna 34 is omitted and antenna 32 is configured to both receive and transmit electronic signals.

Substrate 18 includes outer periphery 21 inside of which a portion, and preferably the entire antenna 32 extends or lies. In particular, the antenna 32 is preferably provided within the confines of periphery 21. According to one embodiment, antenna 32 has a length within the range of 80 mm - 95 mm and is tuned to a frequency of 2.45 GHz.

Conductive trace 30 additionally includes a plurality of power source terminals, including a first connection terminal 53 (shown in

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phantom in Fig. 3) and a second connection terminal 58. Connection terminals 53, 58 are formed on support surface 25 of card 10.

The illustrated card 10 includes a power source 52 and integrated circuit 54 individually mounted on support surface 25 and supported by substrate 18. Power source 52 is provided within antenna 32 in the depicted embodiment. Passive components (e.g., capacitors 57) may also be mounted on support surface 25.

Power source 52 provides operational power to electrical components within card 10, including integrated circuit 54. In the illustrated embodiment, power source 52 is a battery. The battery is preferably a thin profile battery which includes first and second terminals of opposite polarity. More particularly, the battery has a lid or negative (i.e., ground) terminal or electrode, and a can or positive (i.e., power) terminal or electrode.

Conductive epoxy is applied over desired areas of the support surface 25 using conventional printing techniques, such as stencil printing, to assist in component attachment described just below. Alternately, solder or another conductive material is employed instead of conductive epoxy.

Power source 52 and integrated circuit 54 are provided and conductively bonded on the support surface 25 using the conductive epoxy. Integrated circuit 54 can be mounted either before or after the power source 52 is mounted on the support surface 25.

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1 First and second connection terminals 53, 58 are coupled to the
2 integrated circuit 54 by conductive epoxy in accordance with a preferred
3 embodiment of the invention. The conductive epoxy also electrically
4 connects the first terminal of the power source 52 to the first
5 connection terminal 53. In the illustrated embodiment, power source 52
6 is placed lid down such that the conductive epoxy makes electrical
7 contact between the negative terminal of the power source 52 and the
8 first connection terminal 53.

9 Power source 52 has a perimetral edge 56, defining the second
10 power source terminal, which is disposed adjacent second connection
11 terminal 58. In the illustrated embodiment, perimetral edge 56 of the
12 power source 52 is cylindrical, and the connection terminal 58 is arcuate
13 and has a radius slightly greater than the radius of the power
14 source 52, so that connection terminal 58 is closely spaced apart from
15 the edge 56 of power source 52.

16 Subsequently, conductive epoxy is dispensed relative to perimetral
17 edge 56 and electrically connects perimetral edge 56 with connection
18 terminal 58. In the illustrated embodiment, perimetral edge 56 defines
19 the can of the power source 52, such that the conductive epoxy
20 connects the positive terminal of the power source 52 to connection
21 terminal 58. The conductive epoxy is then cured.

22 First and second connection terminals 53, 58 are coupled with
23 integrated circuit 54 providing operational power and an electrical
24 ground reference thereto. Antenna 32 is coupled with the integrated

certain embodiments. Such outputting or communicating of the electronic signals via the modulator comprises one of transmitting the electronic signals and reflecting received signals. Typically, the modulator is configured to communicate an identification signal responsive to the reception of an appropriate polling signal.

The identification signal outputted via the modulator identifies the particular card 10 communicating the identification signal in accordance with one embodiment of the present invention. In one embodiment, the identification signal corresponds to identification indicia (described in detail below) encoded upon a side surface 41 of the card 10.

Referring to Fig. 4, an encapsulant 44, such as an encapsulating epoxy resin material, is subsequently formed to encapsulate a portion of the substrate 18. Resin encapsulant 44 covers integrated circuit 54, power source 52, conductive circuitry 30, and a portion of the support surface of substrate 18. Resin encapsulant 44 and substrate 18 define the card-thin housing 27 of the card 10. Substrate 18 comprises the upper surface 40 of card 10 and encapsulant 44 comprises the lower surface 42 of card 10. In one embodiment, housing 27 of card 10 has a length of about 3.375 inches, a width of about 2.125 inches, and a thickness less than or equal to about 0.090 inches. The thickness of the sides 41 is less than the lengths and widths of upper surface 40 and lower surface 42 in the described embodiment.

An exemplary resin encapsulant 44 is a flowable encapsulant. The flowable encapsulant 44 is flowed to encapsulate substrate 18.

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1 Encapsulant 44 is subsequently cured following the appropriate covering
2 of the integrated circuit 54, power source 52, conductive circuitry 30,
3 and support surface of substrate 18. The curing of encapsulant 44
4 forms a composite substrate or solid housing 27 which comprises
5 substrate 18 and encapsulant 44.

6 In the exemplary embodiment, such epoxy encapsulant 44
7 constitutes a two-part epoxy having a resin and a hardener which are
8 sufficient to provide a desired degree of flexible rigidity. Further
9 details regarding encapsulation of electronic communication device 10 are
10 described in U.S. Patent Application Serial Number 08/800,037, filed
11 February 13, 1997, assigned to the assignee of the present application,
12 and incorporated herein by reference.

13 Still referring to Fig. 4, some of the sides or side surfaces or
14 edge surfaces 41 of card 10 are shown. The sides 41 extend
15 intermediate upper surface 40 and lower surface 42. Substrate 18 and
16 encapsulant 44 form sides 41 of the illustrated card 10.

17 In accordance with the present invention, visibly perceptible
18 information 43 is provided upon one or more sides 41 of card 10. In
19 the depicted embodiment, visibly perceptible information 43 comprises
20 alphanumeric characters which are provided upon the encapsulant 44.
21 The illustrated visibly perceptible information 43 comprises identification
22 indicia. More specifically, the illustrated identification indicia identifies
23 the assignee of this patent application, and the date of manufacture and
24 a lot number corresponding to the particular card 10 upon which the

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indicia is encoded. In particular, identification indicia can identify the particular electronic communication device or card 10 upon which the indicia is encoded. Visibly perceptible information 43 can additionally include information regarding issuance of the card 10 for facilitating the tracking thereof. Visibly perceptible information 43 can comprise more, less or other information.

The height of the visibly perceptible information 43 is represented by dimension "h" in Fig. 4. The height of visibly perceptible information 43 can vary depending upon the dimensions of the specific card 10.

For some card applications, a height of visibly perceptible information 43 of less than 50 mils is utilized and preferred. In particular, one exemplary card 10 comprising an electronic communication device having a thickness less than 90 mils was provided with visibly perceptible information 43 having a height less than 47 mils encoded on a side thereof.

Information or indicia may be provided upon cards of other dimensions according to other embodiments of the present invention. For example, the visibly perceptible information 43 is provided upon conventional cards, such as credit cards, according to the alternative embodiments. Such cards are typically only 30 mils thick (in accordance with the International Standards Organization).

One method of encoding the visibly perceptible information 43 on the card 10 includes printing. The present invention encompasses

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1 additional methods of providing the visibly perceptible information on
2 sides 41 of a card 10. In particular, encoding comprises scribing or
3 embossing the visibly perceptible information 43 onto the sides 41 of
4 the card 10 in other embodiments.

5 Referring to Fig. 5 and Fig. 6, two exemplary methods of
6 providing the visibly perceptible information 43 upon at least one of the
7 sides 41 of the cards 10 are shown. The depicted methods provide for
8 printing the visibly perceptible information 43 onto the sides of the
9 cards 10.

10 Referring to Fig. 5, a printing station 72 comprises a holding
11 apparatus 61 and a print head 66 configured to print visibly perceptible
12 information 43 upon side surface 41 of the card 10. Apparatus 61
13 comprises a base support structure 67 and a holding member 69. The
14 illustrated base support structure 67 includes a raised edge 65 for
15 assisting with the holding of the card 10 to be processed. Holding
16 member 69 is provided in an opposing relation to raised edge 65 and
17 is configured hold a card 10 in preferably perpendicular or upright
18 position therebetween.

19 Holding member 69 is configured to move toward and away from
20 raised edge 65 to respectively hold the card 10 for printing, or permit
21 removal of a processed card 10 or insertion of a card 10 to be
22 processed. Holding member 69 and edge 65 operate to support the
23 card 10 at one side thereof.
24

1 Following the fixation of card 10 within apparatus 61, a print
2 head 66 is lowered toward another side 41 of card 10, opposite the
3 supported side thereof. Print head 61 is operable to encode the visibly
4 perceptible information 43 upon side surface 41 of card 10.

5 Additional print heads may be provided to simultaneously print on
6 plural side surfaces 41 of card 10. The card 10 to be processed
7 remains stationary during the printing thereon by the print head 66
8 shown in Fig. 5. The depicted holding member 69 is shorter than the
9 card 10 enabling printing on the upper side 41 thereof. Alternatively,
10 holding member 65 is approximately the same length, or slightly less
11 *than* ~~then~~ the length of card 10.

12 Referring to Fig. 6, an alternative printing station 72a is shown.
13 The cards to be processed are preferably provided in a pre-arranged
14 orientation or stack 68. The stack 68 is provided adjacent a selection
15 roller 73 operable to select a card 10 from stack 68 for processing.
16 One card 10 may be selected while the other cards remain in the pre-
17 arranged stack 68.

18 Following the selection of a card 10 via roller 73, the selected
19 card 10 is guided to a pair of driving processing rollers 70 of printing
20 station 72a. Card 10 is provided intermediate processing rollers 70
21 which subsequently draw card 10 toward print head 66. Print head 66
22 is positioned adjacent to one side of travel of card 10 provided by
23 processing rollers 70. In this illustrated printing method, processing
24 rollers 70 move card 10 relative to or past stationary print head 66

1 during the printing of visibly perceptible information 43 on the side
2 surface 41 thereof.

3 Printing stations 72, 72a include an X-Y grid ink jet plotter
4 according to one aspect of the present invention. More specifically, an
5 exemplary print head 66 comprises a Videojet EXCEL High Resolution
6 Model, available from Video Jet of Woodale, Illinois.

7 The visibly perceptible information or indicia 43 is provided upon
8 encapsulant 44. Numerous conventional cards (e.g., credit cards) *Mark 25*
9 comprise materials such as polyvinyl chloride (PVC) or ~~ABC~~ ^{ABS} *8-13-97* Such
10 materials allow standard inks to be used for printing the visibly
11 perceptible information 43 on sides 41 of cards 10 by ink jet printing
12 or pad printing.

13 In compliance with the statute, the invention has been described
14 in language more or less specific as to structural and methodical
15 features. It is to be understood, however, that the invention is not
16 limited to the specific features shown and described, since the means
17 herein disclosed comprise preferred forms of putting the invention into
18 effect. The invention is, therefore, claimed in any of its forms or
19 modifications within the proper scope of the appended claims
20 appropriately interpreted in accordance with the doctrine of equivalents.
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